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Test Construction

TK 2374

Zero Loss Probe

INSTRUCTION MANUAL

mi

MARCONI INSTRUMENTS

NOTE.

H 52374-900C
C1 - 10/76

TF 2370 Spectrum Analysers prior to Serial No. 164116/001 will require modification with modification kit L 139 before use with the TK 2374 Zero Loss Probe.

INSTRUCTION MANUAL

No. H 52374-900C

for

Zero Loss Probe

TK 2374

Code No. 52374-900C

MARCONI INSTRUMENTS LIMITED
St. Albans, Hertfordshire, England.

M.I. 2c
7/76/A

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Chapter 1 GENERAL INFORMATION

1.1 INTRODUCTION

TK 2374 is a wide band, high impedance, zero loss probe designed for use with the TF 2370 Spectrum Analyser. This instrument also supplies the power for the operation of the probe.

The probe enables signals to be examined at high impedance points where direct connection to the coaxial input of the spectrum analyser is not possible. The probe can also be used for monitoring matched low impedance systems without disturbing circuit conditions. If the system is a 50 Ω one, the power levels indicated by TF 2370 will be correct.

The probe may be used with signals from 50 Hz to 200 MHz at levels up to 1 V peak-to-peak without introducing appreciable harmonic distortion, but the maximum safe input is 200 V d.c. and 4 V peak a.c. This can be extended to either 80 V peak a.c. or 40 V peak a.c. by using the voltage dividers, which reduces the risk of probe damage due to accidental overload.

Typical uses of the probe include the examination of signals in radio transmitters and receivers. RF and IF stages can be analysed, and the output from local oscillators and mixers may be viewed without disturbing the circuit under test.

The probe may also be used in conjunction with the spectrum analyser tracking generator. A typical example is the measurement of IF crystal filters which are designed to operate into a high impedance load.

Accompanying the probe is a comprehensive set of attachments (see Sect. 1.3) to facilitate connection to various types of measuring point.

1.2 DATA SUMMARY

Probe frequency response from 50 Ω source :	500 Hz to 110 MHz ±0.5 dB. At 50 Hz and 200 MHz -3 dB.
Insertion loss at 10 MHz :	0 dB ± 1 dB.
Input impedance :	
POWER ON :	Nominally 100 kΩ at d.c. shunted by not greater than 5 pF at 10 MHz.
POWER OFF :	Shunt capacitance of not greater than 14 pF at 10 MHz.
With dividers :	Nominally 1 MΩ at d.c. shunted by : not greater than 2.5 pF for x100 divider at 10 MHz, not greater than 3.0 pF for x10 divider at 10 MHz.
Output impedance :	50 Ω nominal.
Distortion :	Does not degrade the specified performance of the TF 2370 Spectrum Analyser.
Total harmonic distortion at 500 Hz :	Total harmonic distortion is less than -28 dB when terminated in 50 Ω. Worst case at 1 V peak-to-peak input.
Maximum safe input	
Probe :	4 V peak a.c. superimposed in +200 V d.c.
Dividers :	For x10 40 V peak a.c. superimposed on +200 V d.c. For x100 80 V peak a.c. superimposed on +200 V d.c.
Average noise level :	Between 100 kHz and 110 MHz. Less than -105 dBm with 5 kHz filter and counter OFF and manual sweep.
Probe supply :	Available at front panel of TF 2370, or -7.5 V regulated at 60 mA d.c.
Terminations :	Signal - BNC Supply - Sub-miniature, 3 pin.

Dimensions and weight :	Box dimensions and weight ;
	Height 56 mm. Width 233 mm. Depth 142 mm. Weight 480 g.
Supplied accessories :	Accessory case containing :
	Voltage divider, 10 : 1. Voltage divider, 100 :1. BNC adapter. Probe hook tip. Earth leads (2 off). Sprung earth bayonet. 50 Ω feedthrough termination. Spare probe tips (3 off).

1.3 SUPPLIED ACCESSORIES

A full set of accessories is supplied with each probe. With the exception of the earth leads, all the supplied connecting accessories are a push-fit onto the nose of the probe.

Probe hook tip	Enables the probe to be clipped onto a solder tag or wire etc. To open the clip, squeeze the ring on the hook tip body towards the similar ring on the probe body.
Earth leads	Two leads 75 mm (3 in) and 150 mm (6 in) long are provided. One end of each lead clips onto the waist at the rear of the probe or onto the sleeve at the tip of either the probe or the adapters. The other end is fitted with a crocodile clip.
Sprung earth bayonet	Provides a very low inductance earth connection between the probe and the equipment under test.
BNC adapter	For connection to BNC sockets.
Voltage divider 10:1	Extends the working voltage limit to 10 V peak-to-peak and the safe limit to 40 V peak a.c. superimposed on 200 V d.c. capacitively compensated.

Voltage divider 100 : 1	As above but with a working voltage limit of 80 V peak-to-peak.
50 Ω feedthrough termination	Ensures correct impedance termination for TF 2370 tracking generator output.
Probe tips	Spare probe tips are supplied.
Accessory case	Protective foam-lined plastic case.

Chapter 2 OPERATION

2.1 SELECTION AND USE

The TK 2374 Zero Loss Probe allows you to connect the TF 2370 110 MHz Spectrum Analyser into circuit with minimum loading and without impedance matching. With the addition of the 10 : 1 and 100 : 1 voltage dividers it will also permit the display and measurement of signals whose amplitudes exceed the 1 V peak-to-peak working input voltage limit of the probe.

The probe presents to the circuit under test, a load of 100 kΩ shunted by approximately 5 pF (consisting of the capacitance of the probe nose, stray capacitance and the capacitance of f.e.t. TR1).

WARNING When using the TK 2374 probe at high voltages with the voltage dividers, normal care should be exercised to avoid electric shock. The equipment under test should preferably be switched off when connecting or disconnecting the probe. If this is not practicable, it is recommended that the hook tip is used.

Chapter 3 TECHNICAL DESCRIPTION

3.1 (Circuit diagram - Fig. 7.1)

The circuit may be conveniently divided into two sections; the probe proper, comprising TR1, TR2 and TR3 and the voltage adjustment section comprising TR4 and TR5. Transistors TR1 to TR4 are mounted on the probe board and TR5 is mounted on the voltage regulator board.

TR1 is an f.e.t. chosen to meet the requirements of a device with high input resistance, low input capacitance and a flat frequency response up to the 110 MHz required for the TF 2370 Spectrum Analyser.

The input resistance is determined by R15 which forms one leg of an attenuator when the voltage dividers are in use.

Capacitor C1 is a d.c. blocking capacitor provided to protect the f.e.t. when the probe is connected to a test point on which there is a d.c. voltage. In order that transients in the f.e.t. are reduced to a minimum, C1 has a small value and since C1, together with R3, largely determine the lower 3 dB point, R3 has a correspondingly high value.

The emitter follower TR2 matches TR1 to TR3 whose function is to overcome stage losses and provide unity gain for the probe output.

R8 and C6 provide frequency compensation and since frequency response varies from probe to probe the value of C6 is selected during test.

The probe output to the spectrum analyser is connected by PL B whilst the probe power is supplied via plug PL A. Both of these plugs are connected to the voltage regulator board.

TR5, whose emitter load is contained within TF 2370, together with Zener diode D1 form a voltage dropping stage to -7.5 V nominal.

DC blocking capacitors C8 and C9 isolate the probe supply from the spectrum analyser input attenuator which has a low resistance to earth.

R12 provides adjustment of the biasing of TR1 which is necessary due to the spread of f.e.t. characteristics.

A further voltage dropping stage is provided by TR4 to ensure that a sufficiently negative voltage is available to correctly bias TR1.

Chapter 4 MAINTENANCE

4.1 CAPACITIVE COMPENSATION

The 10 : 1 and 100 : 1 voltage dividers include an adjustable capacitive compensation feature. During manufacture, the dividers are adjusted for the best overall performance and normally should need no further adjustment.

Where optimum response is required at a particular frequency or after prolonged use, the capacitive compensation may be readjusted. To do this, simply slacken the locking ring and then screw the barrel in or out as appropriate. Two spanners are used for this operation, both 11 mm (7/16 in AF) one of which must be no greater than 2.4 mm (3/32 in) thick in order to fit the locking ring.

Lengthening the divider body by unscrewing the barrel decreases the internal capacitance. Correct compensation is achieved when the frequency response of the probe with voltage dividers is comparable to that of the probe without dividers.

After adjustment retighten the locking ring.

4.2 CHECKING COMPENSATION WITH TF 2370 SPECTRUM ANALYSER

The following instructions apply for readjustment for best overall performance :

a) Connect the probe output to the TF 2370 input.

b) Connect the probe input to a 50 Ω feedthrough termination and then via a decade attenuator set to 50 dB and short 50 Ω lead to the TF 2370 tracking generator output.

c) Set the TF 2370 Spectrum Analyser controls as follows :

Centre frequency	:	500 kHz
Vertical scale range	:	1.0 dB/Div
Vertical scale	:	-56 dBm
Horizontal scale	:	0.1 MHz/Div
Filter bandwidth	:	Narrow (1)
Sweep mode	:	Single
Store	:	Refresh A
Display	:	A

d) Store one sweep in Store A. Switch to Refresh B and display A and B.

e) Slacken the locking ring of the voltage divider and insert between the probe and decade attenuator.

f) Set the decade attenuator to either -30 dB or -10 dB depending upon whether the 100 : 1 or 10 : 1 voltage divider is selected.

g) Set the TF 2370 Filter Bandwidth to Wide (3) and Sweep Mode to Auto.

h) Rotate the voltage divider barrel and compare the display with that obtained previously without the voltage divider. Adjust the attenuator response for +0.5 dB at 500 kHz.

j) Observe the low frequency end and check that the display appears flat and that the overall response is within ±1.0 dB up to 1 MHz.

k) Switch TF 2370 Filter Bandwidth to Narrow (1) and Sweep Mode to Single

l) Lock the locking ring finger-tight and store one sweep checking that the response is + 0.5 dB at 500 kHz. Readjust if necessary until the response between l.f. and 1 MHz is within ± 1.0 dB.

m) Lock the locking ring tight.

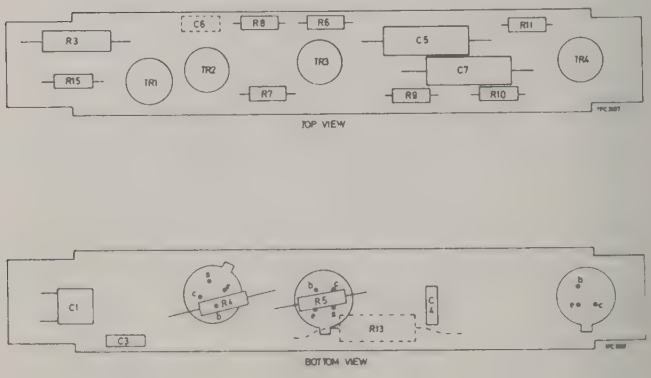

Fig. 4.1 Probe board layout.

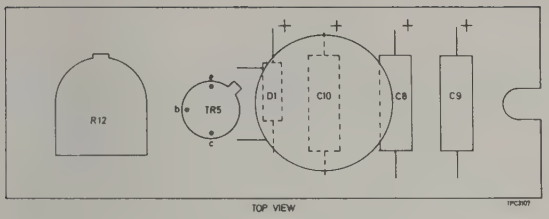

Fig. 4.2 Voltage regulator board layout.

n) Switch TF 2370 Sweep Mode to Auto and set to 10 MHz/Div.

o) Tune to 55 MHz at centre of screen.

p) Store probe only and probe plus divider responses in A and B stores and check that response is within ± 1.0 dB.

q) Readjust the response if necessary, and recheck the response between 0 and 1 MHz.

4.3 FET BIAS ADJUSTMENT

In instances where a bias component or the f.e.t. itself is replaced, the bias may be adjusted by the following method :

a) Connect the probe output to the TF 2370 input (to provide power for the probe).

b) Using a multimeter, measure the voltage between TR3 collector and ground. This may conveniently be measured between C8 and C9 negative end and ground.

c) If necessary adjust R12 for a 1.1 V reading with no signal input to the probe.

d) Examine the display at 110 MHz and adjust R12 on the voltage regulator board for maximum gain at 110 MHz.

4.4 FREQUENCY COMPENSATION

Component replacement may affect the frequency response of the probe which will necessitate adjustment of the probe frequency response as detailed below :

a) Remove existing compensation capacitor C6.

b) Connect a 10 dB pad to the tracking generator output of TF 2370 and link the input of the spectrum analyser via a short length of 50 Ω coaxial cable.

c) Tune the spectrum analyser to 55 MHz and set the controls as follows :

Vertical scale range	:	1 dB/Div
Vertical scale	:	-16 dBm
Horizontal scale	:	10 MHz/Div
Filter bandwidth	:	Narrow (1)
Counter frequency	:	Past centre
Sweep mode	:	Single
Store	:	Refresh A
Display	:	A

d) Press Start button and read one sweep into Store A.

e) Connect the probe output via the same short length of 50 Ω coaxial cable to the spectrum analyser input.

f) Connect the probe input via a 50 Ω feedthrough termination to the 10 dB pad.

g) Select Refresh B and Display B, press Start button and read one sweep into Store B.

h) Examine the stores and compare the levels at 110 MHz. Fit the appropriate value of C6 as given in Fig. 4.3.

Uncompensated insertion loss at 110 MHz (dB) w.r.t. 10 MHz	Compensation capacitor C6 value (pF)
0.7 - 0.8	12.0
0.9 - 1.1	15.0
1.1 - 1.2	18.0
1.3 - 1.5	22.0
1.5 - 1.7	27.0
1.8 - 2.0	33.0

Fig. 4.3 Compensation capacitor values.

Chapter 6 REPLACEABLE PARTS

When ordering replaceable parts, address the order to our Service Division (for address, see rear cover) or nearest agent. Specify the following information for each part required.

1) Type number of instrument.

2) Circuit reference.

3) Description of part.

4) MI code number.

If a part is not listed, state its function, location and description when ordering.

The following abbreviations are used :

C	:	capacitor	Met	:	metal
Carb	:	carbon	R	:	resistor
Cer	:	ceramic	TR	:	transistor
D	:	diode	Var	:	variable
Elec	:	electrolytic	W	:	Watts at 70°C

† Value selected during test to achieve particular performance limits and may be omitted from instrument.

Note : One or more of the components fitted in this instrument may differ from those listed in this chapter; always use as a replacement the same type and value as found in the instrument.

Circuit reference	Description	MI Code
Assemblies		
	Probe assembly complete	44990-161K
	Probe board assembly	44827-675G
	Voltage regulator board assembly	44827-676V
	Cable assembly 3-core	43129-157U
	Cable assembly 2-core	43129-160U
C1	Cer 0.001μF 20% 100V	26386-403T
C3	Cer 0.01μF 20% 100V	26386-497W
C4	Cer 0.1μF 20% 50V	26386-496S
C5	Elec 4.7μF 20% 10V	26486-554G
C6 †	Cer 27pF 5% 50V	26343-470U
C7	Elec 4.7μF 20% 10V	26486-554G
C8	Elec 47μF 20% 6V	26486-593D
C9	Elec 47μF 20% 6V	26486-593D
C10	Elec 47μF 20% 6V	26486-593D
C11	Cer 0.047μF +80-20% 25V	26383-017U
D1	Z5B 6.8V Zener diode	28371-553P
R1	Met film 22Ω 2% ¼W	24773-233M
R3	Carb 10MΩ 10% 1/8W	24321-885N
R4	Met film 200Ω 1% 1/10W	24421-596V
R5	Met film 130Ω 1% 1/10W	24421-594F
R6	Met film 18Ω 1% 1/10W	24421-589L
R7	Met film 51Ω 1% 1/10W	24421-593J
R8	Met film 47Ω 1% 1/10W	24421-592L
R9	Met film 5.1kΩ 1% 1/10W	24421-598W
R10	Met film 2.7kΩ 1% 1/10W	24421-597S

Circuit reference	Description	MI Code
R11	Met film 36Ω 1% 1/10W	24421-587Y
R12	Var cermet 100kΩ 10% ½W	25711-550M
R13 †	Met film 470Ω 2% ¼W	24773-265M
R15	Met film 100kΩ 1% 1/10W	24421-599D
R16	Met film 620 Ω 2% ¼ W	24773-268B
TR1	E300	28459-030H
TR2	BFY90	28452-157R
TR3	BFY90	28452-157R
TR4	BC108	28452-787N
TR5	BC108	28452-787N

Supplied accessories

Probe hook tip	41700-128L
50 Ω feedthrough termination	23443-583H
BNC adapter	43149-005X
Sprung earth bayonet	41700-146C
10 : 1 voltage divider	44990-159A
100 : 1 voltage divider	44990-160B
Earth lead, 150 mm	43129-174T
Earth lead, 75 mm	43129-175P
Accessory case	41690-162J

CIRCUIT NOTES

1. COMPONENT VALUES

Resistors : No suffix = ohms, k = kilohms, M = megohms.
Capacitors : No suffix = microfarads, p = picofarads.
Inductors : No suffix = henrys, m = millihenrys, μ = microhenrys.
† value selected during test, nominal value shown.

2. SYMBOLS

Symbols are based on the provisions of BS 3939.

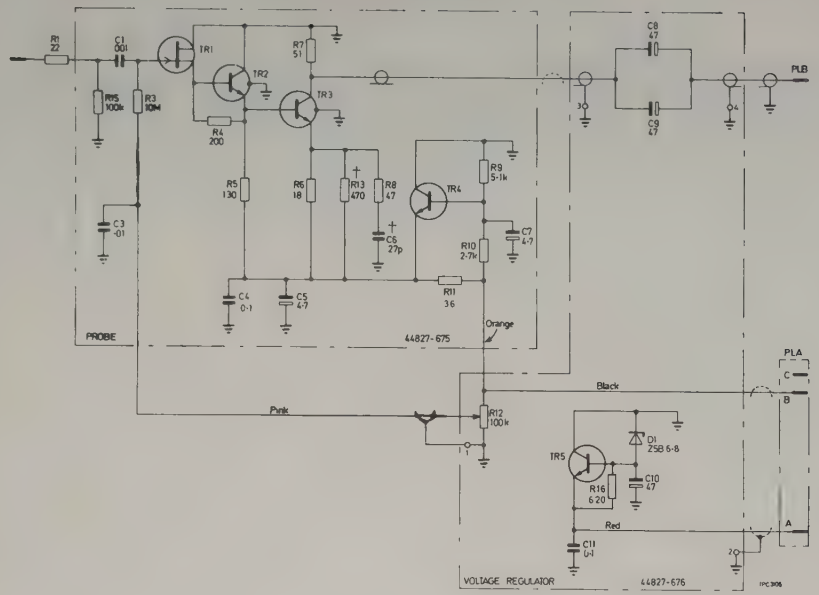

Fig. 7.1 TK 2374 circuit diagram.

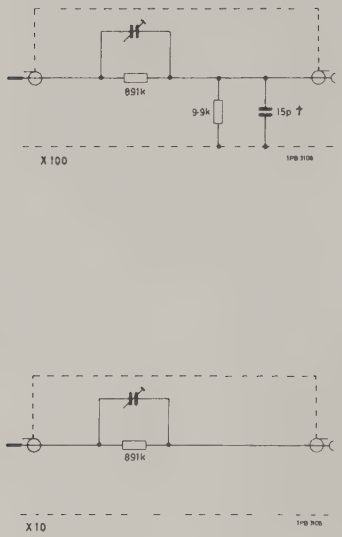

Fig. 7.2 Voltage divider circuit diagrams.

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